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Volume 8

A Compilation of Reports of The Advisory Committee on Nuclear Waste

July 1997 - June 1998

U. S. Nuclear Regulatory Commission

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ABSTRACT

This compilation contains 11 reports issued by the Advisory Committee on Nuclear Waste (ACNW) during the tenth year of its operation. The reports were submitted to the Chairman and Commissioners of the U. S. Nuclear Regulatory Commission. All reports prepared by the Committee have been made available to the public through the NRC Public Document Room, the U. S. Library of Congress, and the internet at http://www.nrc.gov/ACRSACNW.

PREFACE

The enclosed reports are the recommendations and comments of the U. S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste during the period between July 1, 1997 and June 30, 1998. NUREG-1423 is published annually. Volumes 1 through 7 contain the Committee's recommendations and comments from July 1, 1988 through June 30, 1997.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

August 7, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

SUBJECT: COMMENTS ON THE NRC PROGRAM TO PREDICT RISK FROM IGNEOUS ACTIVITY AT THE PROPOSED HIGH-LEVEL WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA

This report contains our observations and conclusions regarding the NRC's High-Level Waste (HLW) Igneous Activity Program. The Committee has followed this program for a number of years and has recently determined the current status of studies on the probability and consequences of an igneous event at the potential HLW repository at Yucca Mountain, Nevada. As a result, we offer a number of recommendations to the Commission with regard to the current program and for bringing this key technical issue (KTI) to closure.

RECOMMENDATIONS

1. On the basis of the maturity of the NRC's Igneous Activity Program and the preliminary results of related risk analysis, we recommend that the Commission bring the current activities of this program to an orderly closure within about one year, providing there are no significant changes in the current risk estimates. To achieve this goal, we recommend that the Commission direct the staff to

   a. Develop criteria for making a decision on the closure of the Igneous Activity Program. The staff should also develop specific criteria for making this decision on the other individual KTIs.

   b. Reorder the program to focus on documenting the NRC's studies on the probability and consequences of igneous activity at Yucca Mountain, including quantification of uncertainties and clarification of assumptions used in the studies.

2. The NRC staff should be directed to convey to the Department of Energy (DOE) its concerns with and responses to DOE igneous activity studies, including the probabilistic volcanic hazard assessment (PVHA) in a clear, comprehensive, and timely manner.

The staff should also promptly transmit the results of current NRC field and modeling investigations that may have significant impact on the risk from igneous activity to the DOE for its study and consideration.

3. Technical expertise in igneous activity will be required and should be maintained by the NRC in the prelicensing period after closure of the igneous activity KTI.

COMMENTS AND DISCUSSION

As part of its continuing interest in the Igneous Activity Program, the Advisory Committee on Nuclear Waste devoted a full-day working group meeting to this topic on April 22, 1997. The Committee was briefed by the staff of the NRC and the Center for Nuclear Waste Regulatory Analyses (the Center), the DOE staff and the DOE contractor who conducted the PVHA expert elicitation, and a representative of the State of Nevada. Consultants included igneous activity specialists from the Ohio State University, Johns Hopkins University, and the U.S. Geological Survey.

PROGRESS OF THE PROGRAM

Igneous activity is one of the KTIs identified by the NRC staff because of its potential risk significance in the tectonically active southwestern United States. The presence of the nearby volcano at Lathrop Wells, which was active 100,000 years ago, and the million year-old volcanic vents of Crater Flat that are as close as 8 km to the proposed repository illustrate why igneous activity had to be investigated at this site. The NRC has developed and conducted a high-quality program dealing with assessing the likelihood of an igneous event intersecting the proposed repository and analysis of the consequences of such an occurrence. The Center work has contributed to advancing state-of-the-art methods for assessing the probability of an igneous event, including development of methods that can be used with a limited number of recognized volcanic events and that incorporate the effect of geologic structure and current tectonism. Further, the Center has demonstrated the utility of high-resolution ground magnetic surveys to identify and map volcanic vents buried in the alluvial basins adjacent to Yucca Mountain. This information is useful in establishing a more accurate record of volcanism over the past several million years and improving the knowledge of geologic structural controls on igneous activity over those previously defined by lower resolution DOE aerial surveys.

The estimated risk from the HLW repository posed by igneous activity, and specifically from volcanism, has been a contentious issue among the NRC, the DOE, and the State of Nevada, all of which have had major characterization or research programs focused on this issue. This controversy can be largely attributed to the infancy of the science of predicting the likelihood of an igneous event, especially over a time span measured in thousands of years. Accurate predictions are problematic because of limitations in the knowledge of the relevant basic geologic phenomena and of acquiring fundamental data. Furthermore, the small number of volcanoes in the Yucca Mountain region limits the accuracy of direct statistical estimation of the frequency of occurrence of igneous activity over space and time. In addition, the lack of an analog for investigating the consequence of molten rock intruding into an underground facility limits the predictability of potential consequences of an event at Yucca Mountain.

The lack of a generally acceptable deterministic method for specifying the level of safety at the proposed HLW repository as a result of igneous activity has made it necessary to perform a risk assessment, including a quantification of the uncertainties in the risk measures. Current NRC estimates of the probability of an igneous event intersecting the proposed repository fall within the range of 10^{-7} to 10^{-8} events/year. The staff also has initiated consequence studies with implementation of a model to determine the anticipated dose to the critical group from an ash-forming eruption that entrains waste from the repository. The NRC is continuing to conduct field and modeling studies to reduce uncertainties and to test and evaluate conceptual models.

In contrast to the NRC, the DOE has terminated its characterization studies and probability analyses with completion of the PVHA expert elicitation, which generally was conducted in a manner consistent with the NRC Branch Technical Position on the Formal Use of Expert Elicitation in the High-Level Radioactive Waste Program, NUREG-1563, November 1996. The results of this study, which are an aggregation of the opinion of 10 volcanism experts, is that the mean probability of an igneous event intersecting the proposed repository is 1.5×10^{-8} events/year with bounds of 10^{-7} to 10^{-10}. The staff has informally indicated in technical exchanges with the DOE that it is concerned about two aspects of the PVHA: the impact of the information obtained from ground magnetic surveying subsequent to the PVHA study and the identification of volcanic zones based on the geologic structure of the Yucca Mountain region. With regard to the former concern, DOE's analysis of recent findings from NRC's ground magnetic surveying has not discerned a significant impact from the new survey data on risk from the igneous activity letter of June 4, 1997, from Stephan J. Brocoum, DOE, to John T. Greeves, NRC. In addition, the definition of "volcanic event" as used in the PVHA needs to be agreed upon by the NRC and the DOE. The results of the DOE's consequence studies will be summarized in the volcanism synthesis report, which will be released later this year. Meanwhile, the DOE has announced its intention to use the NRC's ash-forming eruption entrainment model to determine the consequences and, thus, the risk in its Total Systems Performance Assessment--Viability Assessment (TSPA-VA).

NEED FOR CRITERIA TO MAKE A FINDING ON A KTI

The staff should be directed to establish guidance on the criteria that are used to determine the information, both the type and the amount, required to make a finding regarding the Igneous Activity KTI. These criteria should emphasize the quantification of uncertainty in the parameters that are aggregated to form the risk measures. The scope and assumptions forming the basis for the risk estimate should be transparent and well documented and should clearly indicate the quality and source of all the supporting evidence. The importance of this type of guidance is emphasized by the lack of supporting evidence on the uncertainty in the current estimate of risk from igneous activity at Yucca Mountain.

Although this recommendation is directed to the need for guidance on the criteria for closing out the Igneous Activity KTI, we strongly urge that related guidance for closing out the other KTIs be developed promptly.

FUTURE EMPHASIS OF THE PROGRAM

The Committee believes that based on the significant progress made in the Igneous Activity Program, and the low risk calculated by the staff from a volcanic event, the staff should focus on completing the highest priority tasks that are aimed specifically at reducing uncertainty in the results of models used to depict the repository's performance. Upon completion of these studies, the bulk of the program should be brought to closure in about a year, provided there are no significant modifications in the results compared with those of the present.

We recommend that the staff consider including the following tasks in completing and closing out the Igneous Activity Program.

1. Evaluate the impact of unrecognized igneous events. The number, location, and age of unrecognized igneous events such as unobserved near-surface dikes and alluvium-covered volcanic cones and flows introduce uncertainty in the probability models. To minimize this uncertainty and to test the DOE's conceptual models on which probability estimates are based, the staff is mapping unrecognized volcanic features by conducting high-resolution ground magnetic surveys at sites identified as potential igneous event anomalies in data of the aerial magnetic surveys of the Yucca Mountain region. We concur with these activities, but we urge that the staff be directed to test and document the impact of such possible volcanic features on probability estimates with performance assessment using the number of volcanic features suggested by the occurrence of potential igneous-event anomalies observed in the existing data. These scoping studies should be used to determine which, if any, of these anomalies warrant investigation by ground magnetic surveys. Special attention should be given to evaluating anomalies in the immediate vicinity of Yucca Mountain, where their existence may lead to new models and significant revisions in probability. If the ground magnetic surveys lead to the identification of potential volcanic features, these results should be conveyed to the DOE for further analysis. Ground magnetic surveying of anomalies solely for the purpose of studying structural controls on igneous activity is warranted only in specific situations in which the potential connection between volcanism and geologic structure is clear and can lead to refinement in estimating probabilities.

2. Summarize, evaluate, and document the probability estimates. Currently, there is a range of estimates on the probability of an igneous event disrupting the proposed Yucca Mountain repository. Estimates are available from the DOE, the PVHA, the State of Nevada, and the Electric Power Research Institute. All of these have undergone some level of peer review and thus can be accorded a degree of credibility. In addition, the estimates of the Center should be finalized in the near future and their uncertainties defined. The results of the various studies need to be summarized by NRC, perhaps as part of an issue resolution status report. This summary should impartially explain in a simple qualitative manner the differences in the results and the origins of the differences. Special emphasis should be placed on evaluating (a) the assumptions employed in the various methodologies and in calculating the estimates and (b) the quality of the data input and its impact upon results. This documentation should highlight the model uncertainties.

To support this summary and evaluation, we suggest that a comprehensive discussion of models of igneous systems in the Yucca Mountain region be prepared based on the extensive existing information gathered by the DOE and others. These models should integrate the geological, tectonic, geophysical, and geochemical information into a coherent system. The models should rationalize the probable igneous system dynamics in the context of knowledge on the behavior of active igneous systems. Special emphasis should be placed on integrating the igneous system into current information on tectonic models of the region. This synthesis will be valuable in evaluating all existing models of probability or other models that may be developed before licensing review.

3. Further develop and document the consequence analysis. Preliminary analyses show that the expected annual risk over a 10,000-year time period from an ash-forming eruption at Yucca Mountain to an individual located 20 km downwind in Amargosa Valley is less than 1 mrem. This risk appears to be based on conservative estimates of some parameters, but further sensitivity studies are required to evaluate this estimate and related documentation should be prepared. The Committee urges identification through sensitivity studies of those parameters of consequence models, including indirect effects that may have a significant effect on the repository's performance or that are ill defined. Efforts should be made to reduce uncertainties with carefully targeted investigations, if justified by these analyses. The staff is encouraged to give high priority to evaluating the sensitivity of the dose calculation to the location of critical group.

FOLLOW-ON PROGRAM

The science of igneous processes and systems is very dynamic with rapid, continual growth in knowledge of this discipline and methodologies for improving the related data bases. Thus, we can anticipate improvements in the ability to predict igneous events. As a result, the NRC should maintain sufficient expertise in igneous activity to monitor and evaluate DOE's continuing progress in this discipline. In addition, the NRC should monitor the occurrence of precursors to igneous activity in the Yucca Mountain region, such as microseismic activity and elevation perturbations. Finally, technical expertise in igneous activity will be required when the NRC reviews the DOE's TSPA-VA and conducts its own performance assessments.

COMMUNICATIONS

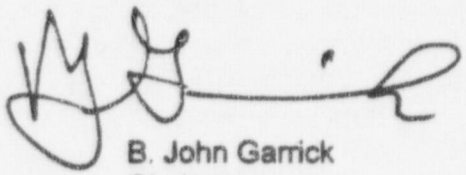
Our review of the NRC's Igneous Activity Program has led us to conclude that although communications have increased and improved between the DOE and the NRC in the past few years, more effective interaction is desirable. NRC should develop its questions, concerns, and conclusions about DOE activities and reports in a timely manner with supporting backup documentation. For example, the Committee urges the staff to document and formally communicate promptly its concerns and the bases for them about DOE's PVHA expert elicitation. In addition, the staff should formally acknowledge and communicate any residual concerns about recent additional probability analyses by the DOE that incorporate new NRC ground magnetic data (letter of June 4,1997, from Stephan J. Brocoum, DOE, to John T. Greeves, NRC). These data identify previously unknown volcanic features in the greater Yucca Mountain region. The NRC also should document its position on the annual probability of

an igneous event intersecting the proposed repository. The NRC staff refers to its estimate of 10^{-7} events /year as a "reasonably conservative upper bound," but the justification of this value is unclear. In addition, neither the uncertainty associated with this estimate nor the assumptions used in its determination have been formally documented and transmitted to the DOE. Presumably, this type of information will be provided in reports being prepared. We urge that these reports be completed in the near term.

CONCLUSION

The maturity and success of the NRC's Igneous Activity program are recognized by the Committee. This recognition, together with the preliminary calculated estimates indicating minimal risk from an igneous event at the proposed Yucca Mountain repository, leads us to the recommendation that the current program be brought to an orderly closure. However, we do make suggestions for modifications and recommend several specific areas for special emphasis in the remaining program. The Committee encourages the use of performance assessment to prioritize activities and the development of guidance to make a decision on terminating a program and closing out a KTI. Although germane to the Igneous Activity Program, this advice applies equally well to the entire prelicensing strategy. Finally, although we recommend the near-term closure of the current Igneous Activity Program, we also encourage the NRC to maintain an expertise within this discipline throughout the prelicensing period of the high-level radioactive waste effort.

Sincerely,



B. John Garrick
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

October 8, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: Comments on Performance Assessment Capability in the NRC High-Level Radioactive Waste Program

The purpose of this letter is to advise the Commission about the NRC staff's performance assessment (PA) capability in the High-Level Radioactive Waste (HLW) Program. Performance assessment is an important tool in NRC's prelicensing activities, including the following: understanding the importance of specific site characteristics and the design of engineered features to the performance of an HLW repository at Yucca Mountain, prioritizing key technical issues (KTIs) and staff activities, developing revised standards and regulations for licensing, and preparing for review of the Department of Energy's (DOE's) viability assessment (VA) of the proposed repository. The evaluation of staff HLW PA capability continues to be a priority issue of the Advisory Committee on Nuclear Waste (ACNW).

The observations and comments in this letter have been developed, in part, on the basis of the 93rd ACNW Meeting at the Center for Nuclear Waste Regulatory Analyses (hereafter the Center) in San Antonio, Texas, on July 23-24, 1997. The ACNW previously reviewed and commented on staff HLW PA capability in letters dated December 2, 1991, and May 27, 1994.

Recommendations

The Committee makes the following recommendations:

- Selected capabilities should be added to the program to provide further assurance that the staff has the ability to assess the containment capacity of the engineered systems. Support for KTIs relating to the near-field performance of the repository should be restored. Among the disciplines for which the ACNW believes added capability is necessary are engineering analysis, materials science, and chemistry. The crosscutting discipline of corrosion science and engineering is also an essential part of the mix.

- The PA models should be structured to represent repository performance as realistically as possible and thereby provide the necessary information for regulators to make decisions in the context of the full state of knowledge about the performance measures of the repository. Improved coordination and communication between the NRC staff and the Center will be essential.

- Greater emphasis should be given to collecting, organizing, and documenting the supporting evidence for the performance assessments to enhance acceptance of the results. An important element of this is improvement in communicating the abstraction of process models into probabilistic models. Of particular interest to the Committee is visibility of the treatment of such phenomena as chemical and geological processes leading to the mobilization of radionuclides in the near field.

- A working version of the NRC's Total Performance Assessment code, version 3.1 (TPA-3) should be implemented as soon as practicable.

- A program for verifying TPA-3 should be developed. TPA-3 should be benchmarked against other codes for Yucca Mountain. The Committee also encourages exposure of the methods of TPA-3 and associated background information to the scientific community through extensive and timely peer review.

Accomplishments

The Committee commends the staff for its many impressive accomplishments in upgrading and preserving a dedicated HLW PA team in the face of budget cuts and programmatic uncertainties. The organization of the HLW Program around a specific set of KTIs and the grouping of expertise and disciplines within the KTIs provides an important means of focusing the staff's efforts on issues most important to performance of the repository. Performance assessment is important in the staff's efforts to provide integration across disciplines in the KTIs and to set priorities for activities. The Committee was pleased to see the clear integration of PA with other Yucca Mountain activities. This effort has led to the development of sound, near-term plans for prelicensing activities, including resolving outstanding issues and preparing for review of DOE's total system performance assessment supporting the viability assessment (TSPA-VA). The revised and updated TPA-3 code increases the staff's capability in performance assessment modeling. The code should facilitate the KTI investigations with its ability to evaluate the importance of specific site characteristics and the effectiveness of engineered barriers. The ability to conduct sensitivity and uncertainty analyses for subsystems and for the total system is improved. The development of the code is a solid effort and we encourage the staff to pursue aggressively the implementation of TPA-3. Many of these staff activities conform to recommendations contained in the ACNW letter of May 27, 1994, on PA capability.

Engineered Barrier System

The ACNW is concerned about the staff's capability to evaluate quantitatively the engineered barrier system of the proposed Yucca Mountain repository. This concern is punctuated by lessons learned from PA, including the apparently increasing dependence on engineered barriers to demonstrate compliance with a dose- or health-based standard for the repository. With increasing evidence that engineered systems must be an important part of the waste isolation strategy for Yucca Mountain, it is important that these systems receive extensive scientific and engineering scrutiny.

We are concerned about the decision to reduce the effort at the Center on certain KTIs, most

notably those dealing with engineered barriers and radionuclide transport. The shifting emphasis of the DOE to the performance of engineered systems accents the need for the Commission to provide resources to restart work on the KTIs most important to an independent assessment of the performance of engineered systems and near-field radionuclide transport. A concern is that without restarting the work of the NRC staff and the Center, the performance assessment effort, including the TPA-3 code, will not have the scope to assess adequately the DOE work. The Committee urges the Commission to act on this issue as soon as practicable.

Beyond the issue of the scope of the engineered systems assessment capability of the NRC staff, the ACNW believes that added capability is necessary to analyze adequately the engineering design of long-lived, passive high-integrity systems. In particular, additional staff effort is required in engineering analysis, materials science, and chemistry (especially corrosion and colloid chemistry) to have the full capability to assess the engineered systems.

Realistic Performance Assessment Models

The ACNW has three primary points to make regarding the staff's performance assessment modeling activities: (1) the PAs should have a risk-informed perspective; (2) the PAs should be transparent about the supporting evidence (data and information); and (3) the relationship between process model and probabilistic calculations needs to be made clear.

Risk-informed performance assessment provides the opportunity to assess *realistically* the performance of an HLW repository. Our concern is that the TPA-3 activity is relying too much on bounding and worst-case calculations. Although bounding calculations are a very useful part of any technical investigation in providing insights on what is important to the performance measures of a model, such calculations are often of little value in representing what is likely to happen. In the opinion of the ACNW a much preferred approach is to limit bounding and worst-case calculations to the task of scoping the investigation and deciding what may or may not be important to model. Decision making requires more information. The decision-maker needs to know the total range of uncertainty of the performance measures. The primary tool for communicating uncertainty, rather than just an upper bound, for example, is to embed the performance measures in probability distributions so that the full range of values and all their supporting evidence are visible. For example, if the value preferred by the regulator is the 90th percentile value, then it is explicitly clear just how conservative the regulator has chosen to be.

The Committee stresses the importance that the evidence (i.e., data and all other information) that is the basis of the PA model be clearly visible, particularly regarding the abstraction from physical process models to probabilistic calculations. We are especially concerned with the abstraction of information about the engineered systems, especially under the circumstances of not having a fixed design. In addition, supporting evidence for modeling important phenomena such as the chemistry of redox reactions is weak. Our current impression is that more attention is being given to methods than to the required information to support those methods.

Analysis Capability

The ACNW was impressed with the progress in the development of NRC's TPA-3 code. We are anxious to follow the development of TPA-3 and look forward to more discussions with the staff.

The ACNW urges the staff to implement a working code in an expeditious manner so that the code is fully functional as the TSPA-VA analyses are made available to NRC.

The Commission has indicated an interest in moving toward a risk-informed, performance-based philosophy of regulation. Of concern to us is whether the TPA-3 effort is keeping pace with the development of methods and ideas on how to implement such a philosophy.

An issue with TPA-3 is how to verify the code. The problem as stated by the staff is that because the code is designed specifically for the Yucca Mountain site, international bench marking is almost impossible. It is true that parts of the code, such as NEFTRAN (NEtwork Flow and TRANsport), have been benchmarked. The NRC staff must see that TPA-3 is benchmarked against applications of other codes to Yucca Mountain. The ACNW also believes that the NRC staff should pursue other avenues of peer criticism of its codes, such as publication in refereed engineering and scientific journals.

Although the ACNW believes that it is important to develop a PC compatible version of the code to reach more users, we would not like to see other important activities compromised to reach this goal. A PC compatible version should not be created at the risk of oversimplification. Meanwhile, to conduct a full range of analyses in reviewing DOE's TSPA-VA, the staff requires the NMSS Advanced Computer System or a suitable alternative.

We believe that these comments provide constructive guidance on the future direction of the performance assessment effort and look forward to following NRC staff progress in this important activity.

Sincerely,

B. John Garrick
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

October 31, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

SUBJECT: RECOMMENDATIONS REGARDING THE IMPLEMENTATION OF THE DEFENSE-IN-DEPTH CONCEPT IN THE REVISED 10 CFR PART 60

This letter communicates the recommendations of the Advisory Committee on Nuclear Waste (ACNW) for adopting a revised approach to the existing subsystem performance criteria in 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," to implement the defense-in-depth (DID) concept.

RECOMMENDATIONS

1. The Committee endorses the concept of defense in depth, including institutional as well as structural aspects. In particular, we recognize the benefit of multiple barriers of protection. The Committee recommends that sound principles be set forth guiding the implementation of the concept of defense in depth. The Committee, however, does not endorse the establishment of rule-based subsystem requirements as exist in 10 CFR Part 60.

   We believe that guidance will depend to a large extent on proper construction of a performance assessment (PA) to expose the role of design elements, operational elements, and multiple barriers, including interdependency of the multiple barriers. The regulations should be clear on how the DID concept should be implemented. The Department of Energy (DOE) (or any future license applicant) should be directed to furnish documentation that shows how the DID concept has been implemented in meeting the overall performance goal.

2. The Committee recommends that NRC performance assessment procedures be structured so that the effectiveness of individual barriers can be identified explicitly in the total system performance.

   The PA should clearly expose the effectiveness and role of selected individual barriers such as the engineered systems and the natural geological setting. The assessment of individual barriers should include a quantification of the uncertainties involved and the inter-relationships among barriers. The Committee believes that there are methods for quantifying the role of individual engineered barriers and the containment capability of the natural setting. To achieve the capability to assess the effectiveness of individual barriers, both geological

and engineered, it may be necessary to modify the analysis methods, including the PA models, and to enhance the database to reveal the performance of individual barriers. The Committee also believes that exposure of the public to a PA process that is sufficiently transparent could lead to improved public confidence in the ability of the repository to isolate waste effectively.

This letter is one in a series of letters to the Commission conveying the ACNW's views on aspects of the NRC staff's strategy for revising 10 CFR Part 60. Previous letters on the staff's strategy for revising 10 CFR Part 60 include "Issues and NRC Activities Associated with the National Research Council's Report, 'Technical Bases for Yucca Mountain Standards,' " February 9, 1996; "Time Span for Compliance of the Proposed High-Level Waste Repository at Yucca Mountain, Nevada," June 7, 1996; and the "Reference Biosphere and Critical Group Issues and Their Application to the Proposed HLW Repository at Yucca Mountain, Nevada," April 3, 1997. Our recommendations are formulated on the basis of presentations made to the Committee during the 90th, 91st, 92nd, and 93rd meetings by the NRC staff, the DOE staff and its contractors, the State of Nevada, the National Research Council, and representatives from industry, as well as on the basis of the Commission's policy on risk-informed, performance-based regulation.

The Nuclear Waste Policy Act of 1982, as amended, mandates NRC to develop technical criteria for HLW disposal that are consistent with the Environmental Protection Agency (EPA) generic standards and provide for a system of multiple barriers. The Energy Policy Act of 1992 mandates that NRC conform its regulation to the final EPA standards for Yucca Mountain, the latter of which are to be based on and consistent with recommendations made by the National Academy of Sciences' Committee on Technical Bases for Yucca Mountain Standards (TBYMS). As directed by the Commission, the NRC staff is currently pursuing development of site-specific regulations for Yucca Mountain to implement the forthcoming EPA site-specific standards for Yucca Mountain.

In this letter, the concept of DID refers to the methods of design, construction, and operation of a geological repository for HLW in ways that aim to ensure safety in the face of considerable uncertainty in our knowledge of various processes. The implementation of DID in the repository context entails an analysis that exposes the contribution of each design element, each process (or set of processes) in the natural geological setting, and each operational technique to the safety of the repository. The DID concept includes (but is not identical to) the notion of multiple barriers that act to isolate the waste. One of the major issues regarding regulation within the DID framework is whether and how prescriptive requirements (so-called subsystem requirements) should be placed on classes of these barriers. As discussed below, the Committee believes that the adoption of a risk-informed approach eliminates the need for prescriptive subsystem requirements for Yucca Mountain.

The present form of 10 CFR Part 60 partly implements the DID approach by prescribing performance requirements of particular barriers.[1] As noted in the Statement of Considerations to 10 CFR Part 60, in addition to the natural barrier provided by the geological setting, this multiple barrier approach identifies two engineered barriers: the waste package and the underground facility. The Statement of Considerations notes that the multiple barrier concept is implemented by the performance objectives or requirements, as well as by more detailed siting and design criteria. The Committee

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[1]Paraphrasing the regulation, the performance requirements specify substantially complete containment of waste packages for 300 to 1,000 years after permanent closure, release rates of radionuclides from the engineered barrier system less than one part in 100,000 per year at 1,000 years after closure, and a prewaste-emplacement groundwater travel time of at least 1,000 years.

recognizes that inclusion of the quantitative subsystem performance requirements in the rule was thought to provide additional confidence to compensate for uncertainties associated with predicting the behavior of a repository over thousands of years and for the general lack of experience and confidence in analyzing repository performance.

The Committee supports the NRC's view expressed in the Statement of Considerations to 10 CFR Part 60 that the performance of the engineered portion of the repository and the geological system must each make a definite contribution to waste isolation. The Committee recognizes the need for reliance on multiple and diverse barriers as part of the DID concept. However, we do not endorse the implementation of the DID concept through inclusion of prescriptive subsystem criteria in the revised 10 CFR Part 60.

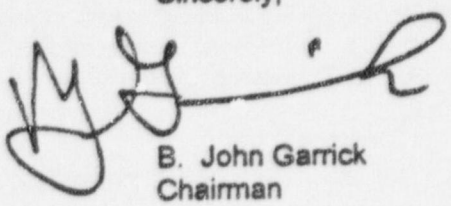
Current thinking, which is supported by much experience and empirical evidence in both probabilistic performance assessment and site characterization is that performance-based regulations are much more efficient and effective in protecting health, safety, and the environment than are "command-and-control" approaches. Focusing on quantitative subsystem requirements for the proposed repository at Yucca Mountain would run counter to this thinking because it potentially could force a design that would increase overall risk even though all subsystem requirements were met. A hypothetical example may clarify: a requirement that backfill in the repository be capable of substantially retaining all radionuclides leached from the waste package for 1000 years might be imposed. Such a requirement, which on the surface could be seen as beneficial, might force a design that would diminish significantly the lifetime of the waste canister by changing geochemical conditions in the near field. The outcome could be an increased risk to affected populations relative to a repository without backfill. It is this type of potentially adverse effect from subsystem requirements that an overall performance-based regulation would avoid. Consideration of such hypothetical examples supports our main conclusion that an overall performance-based regulation in the context of a risk-based standard is a superior tool for promoting safety relative to imposed subsystem requirements.

A major problem with the current version of 10 CFR 60.113, "Performance of Particular Barriers After Permanent Closure," which prescribes performance of particular barriers, is that it is not clear just how relevant any subsystem performance requirement is to the overall safety performance of the repository. Furthermore, in the analysis of repository performance, interdependency of barriers makes it difficult to assess precisely the role of individual barriers. For example, the assumed rate of percolation of water through the repository affects the performance of all subsystems. The connection between barrier performance and overall performance is very site- and design-specific. Prescribing individual barrier performance may create a design that is imbalanced in terms of individual barrier effectiveness. Subsystem requirements may also result in very poor designs from an economic standpoint. The ACNW's view is consistent with the TBYMS report, which cautioned against imposing subsystem requirements that may inadvertently result in a suboptimal repository design.

The primacy of an overall performance-based regulation does not imply that DOE, as the license applicant for Yucca Mountain, would not have to demonstrate convincingly to the NRC that both the geological system and multiple aspects of the engineered system were effective in providing waste isolation capacity. The NRC should insist that the applicant's PA clearly and quantitatively indicates how each barrier contributes to meeting the overall safety objective. This information should provide the basis for an informed decision on the license application.

The approach that we recommend offers many advantages over prescriptive subsystem requirements. First, it allows taking maximum advantage of site- and design-specific properties and features. Second, it is a clear example of risk-informed, performance-based regulation. The important contributors to risk can be ranked, thus providing a basis for prioritizing design changes and risk management activities. Third, it clarifies the degree of dependence of overall repository performance on individual barriers. In a sense, the safety margins of the various barriers are made more explicit through quantification.

Sincerely,



B. John Garrick
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

October 31 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: Application of Probabilistic Risk Assessment Methods to Performance Assessment in the NRC High-Level Waste Program

This letter provides the Commission with the Advisory Committee on Nuclear Waste's (ACNW's) observations and recommendations on the application of probabilistic risk assessment (PRA) methods to performance assessment (PA) in the High-Level Radioactive Waste (HLW) Program. We believe our recommendations enhance the Commission's policy of increasing the use of risk-informed, performance-based approaches in waste management. The Committee considers this issue a high-priority item because of the need for transparency and clarity[1] in the decision-making process, not only for the NRC's prelicensing and licensing activities for the proposed HLW repository at Yucca Mountain, but also for other waste-related activities, such as decommissioning, low-level waste management, and management of uranium mill tailings. The complexity of the proposed repository system at Yucca Mountain and the models that are intended to represent its performance over time necessitates some method for presenting the results that clearly indicates to the decision makers and to the public what the expected performance will be and what the main subsystem components are that contribute to that performance. The Committee firmly believes that certain PRA approaches can be successfully applied to the PA results for waste management.

Summary and Recommendations

In general, the Committee is impressed with the methods employed by both the NRC and the Department of Energy (DOE) in their work on PA. Analytically characterizing the performance of the proposed Yucca Mountain repository involves an unprecedented application of physical process modeling and probability methods. The progress in abstracting site characterization and facility design information into probabilistic PA (PPA) models has been extensive.

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[1] By "transparency" we mean the ability to see through the entire process, to understand the process; by "clarity" we mean the ability to discern the key elements in the analyses.

Despite this considerable progress, the Committee does have some concerns about the staff's PA program. These concerns center around two primary issues. The Committee believes that PAs should follow the intent and spirit of the risk-assessment philosophy of developing realistic models with uncertainties included, as opposed to developing bounding or worst-case calculations. We also believe the assessments should enable unraveling the results into rank-ordered contributors to the overall risk or to the performance of the repository. The latter provides a solid basis for developing confidence in the design and meaningful risk-management practices.

Therefore, we recommend the following:

- To as great an extent as possible, realistic models and parameters should be used so that the results of the PAs represent the full range of values (i.e., upper and lower bounds, central tendency parameters, and the values in between) that realistically can be supported by the evidence.

- Bounding analysis and worst-case calculations should be used primarily to screen out issues of little or no concern, i.e., to scope the analysis, but not to be the basis for generating results that are clearly out of context with reality and, thus, that do not produce a framework for judging reality.

- The NRC Total Performance Assessment code, version 3.1 (TPA-3), should be reviewed for unrealistic results that arise from bounding calculations embedded in the code. Ultraconservative model assumptions and parameter values should be replaced with more realistic assumptions and probability distributions.

- An event tree or a similar approach for evaluating the TPA-3 model results emphasizing the systematic and efficient unraveling of results into specific contributors to performance should be developed and applied.

- Appropriate importance measures should be developed. We understand that staff from both the NRC and the Center for Nuclear Waste Regulatory Analyses (CNWRA) are currently working on this issue. The Committee encourages the continuation of this effort.

- Subsystem performance measures at specific pinch points[2] in the analysis, such as the flux of radionuclides released from the repository into the geosphere, should be defined. These performance measures might include the integrated release of radionuclides over time, or the release rate as a function of time. Both the NRC and DOE have indicated that their respective models are capable of providing intermediate results (e.g., source term output to the geosphere). Hence, the approach can take advantage of the existing model subsystem output capabilities.

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[2] Pinch points occur where outputs (material, energy, or information flow) from one module of the total system model become the inputs to another module.

Background

The comments in this letter have been developed, in part, on the basis of a working group meeting on the application of PRA methods to PA during the 93rd ACNW Meeting at the CNWRA in San Antonio, Texas, on July 24, 1997. Participants included representatives from: the PRA field; the Electric Power Research Institute; the DOE's Yucca Mountain Project; the Waste Isolation Pilot Plant PA Project; and the NRC staff. The Committee benefited from detailed NRC staff presentations on the HLW PA program and the NRC's TPA-3 code during the previous day's ACNW meeting on HLW PA capability. The Committee members and staff also observed the NRC/DOE technical exchange on DOE's Total System Performance Assessment activities and NRC's iterative performance assessment (IPA) efforts on July 21-22.

Accomplishments

The NRC staff's work on the revised TPA-3 code represents a pivotal effort. The staff has made longstanding, extraordinary efforts to ensure that appropriate site characterization information is collected and to understand the processes that ultimately may determine the performance of an HLW repository at Yucca Mountain. As part of the IPA program, the staff has developed approaches for abstracting site and design information and process models that have been incorporated into the TPA-3 model. The Committee commends this effort and notes that the recommendations previously presented are aimed primarily at developing more realistic models, mainly with respect to assumptions and scope, and improvements in processing the information that is the current output of the TPA-3 model. In particular, the Committee is not suggesting basic changes in the model but is encouraging more realistic assumptions and improvements in the methods for analyzing the results of the PAs.

Realistic Models

Probabilistic concepts have their greatest value in communicating confidence in the outcome of an event or process. They provide the tool for analysts to express their full state of knowledge about how likely an event or process is. The introduction of probabilistic analysis does not replace the deterministic models; rather, it allows a richer interpretation of results. Of course, the probabilities must be supported with appropriate evidence, and to the extent that the evidence is weak, the uncertainties are greater. Such communication is the essence of probabilistic analysis. Thus, the aim of PPA should be to "tell it like it is" on the basis of all the evidence available. The result is what the experts and, with public participation, society believes is likely to happen. A logical framework then exists to make decisions as conservative as desired, but within a framework that defines the level of conservatism.

Interpretation of the Results

Although there are clear differences between nuclear power plant PRAs and waste system PAs (which have been discussed with the Commission by both the NRC staff and the ACNW), a number of key similarities makes it possible to consider the use of PRA methods, such as the top-down event tree approach, to facilitate interpretation of PA results. Both PRAs and PAs

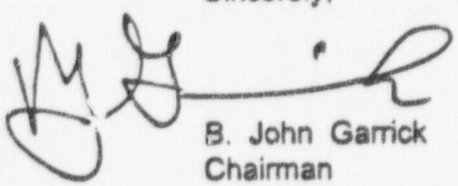
begin with a set of initial conditions (in PRAs these are called initiating events). In PAs, the initial conditions may consist of such phenomena as climate conditions, volcanic events, seismic events, or human intrusion. Both PRA and PAs use a modular approach to the analysis (in PRAs, this includes level-I, -II, and -III analyses; in PAs this includes analyses for infiltration, engineered barriers, source term, geosphere transport, biosphere uptake, and dose to the critical group). Both methodologies can be decomposed into logical pinch points for which specific performance measures can be developed (such as core damage for PRA and integrated release of radionuclides into the geosphere for PA). The goal is to develop a systematic and efficient method for identifying different inputs and outputs of the various modules that make up the full PA model in terms of their individual contribution to the overall performance of the repository. To do this may require a different approach in the way that scenarios are structured for PA.

At our workshop, candidate methods were presented for systematically and efficiently interpreting the results from PAs using a post-processing tool, such as an event tree approach. The postprocessor could make the results more transparent and sharpen our understanding of the total system model. The Committee believes that these techniques should be explored for TPA-3.

An important benefit of the proposed approach to interpreting PA results should be with respect to the program for evaluating key technical issues (KTIs). The postprocessor should greatly facilitate the task of determining the importance of individual KTIs to the overall performance of the repository. This will allow staff to allocate already scarce resources to the KTI program so that the focus is on the most important KTIs and subissue areas. The approach will also prove useful in determining where uncertainties are important to demonstrating compliance and where they do not really matter, even if they are large. Sometimes there is a tendency to focus only on the relative magnitude of the uncertainty in a model or parameter (large uncertainty is considered bad and small uncertainty is considered good), rather than on whether that uncertainty makes any significant difference to the bottom-line result, which is ultimately the health and safety of the public. The goal in the near term would be to avoid spending large resources on trying to reduce uncertainties that do not matter to the result. In the longer term, the goal is to be able to defend in a licensing hearing the specific staff positions in the safety evaluation report vis-a-vis the magnitudes of the uncertainties for different subsystems and for total system performance.

The Committee looks forward to following the staff's program in PA, and we are particularly interested in its progress on the two issues of transparency of results and the use of realistic models.

Sincerely,



B. John Garrick
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

December 2, 1997

MEMORANDUM TO: Commissioner Nils J. Diaz

FROM: B. John Garrick, Chairman,
Advisory Committee on Nuclear Waste

SUBJECT: HEALTH EFFECTS OF LOW-LEVEL IONIZING RADIATION

This is in response to your memorandum of October 16, 1997, which addressed the July 10, 1996, report to the Commission by the Advisory Committee on Nuclear Waste (ACNW).

To our knowledge, the current status of ACNW's three recommendations remains as described in the August 9, 1996, letter from the Executive Director for Operations (EDO). This letter indicated that the National Council on Radiation Protection and Measurements' (NCRP's) committee assigned to this NRC-sponsored study, Scientific Committee 1-6 on Linearity of Dose Response, "...is an excellent representation of the expertise needed to complete this task "and that "All relevant data will be reviewed and incorporated into the NCRP Council Report." The EDO's letter also indicated that among the 55 collaborating organizations that will be given an opportunity to comment are "the National Institute of Standards and Technology, the Nuclear Regulatory Commission and the Environmental Protection Agency, the Radiation Research and Health Physics societies, and a variety of medical academies, colleges, and associations."

The ACNW staff has talked to the NCRP Executive Director and has received a listing of the data and reports submitted to NCRP Scientific Committee 1-6. Although we could not attend any of the deliberations of Scientific Committee 1-6, because they were closed sessions, our staff has had discussions with several of the presenters.

The ACNW continues to believe that the health effects of low-level ionizing radiation are of fundamental importance and maintains an active interest in it. We intend to hold a working group meeting on the subject early in 1998 to gain insight on new scientific perspectives and implications of pending legislation. In addition, we will continue to monitor the progress of the NRC-sponsored grant to the NCRP, which is anticipated to be completed in 1998.

We appreciate your interest in this subject and will inform you promptly of future activities of the ACNW related to this most important topic.

cc: Chairman Jackson
Commissioner Dicus
Commissioner McGaffigan

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

December 23, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: 1998 STRATEGIC PLAN AND PRIORITY ISSUES FOR THE ADVISORY COMMITTEE ON NUCLEAR WASTE

The Advisory Committee on Nuclear Waste (ACNW) has developed a Strategic Plan that includes priority issues it will consider in 1998. A copy of the plan is attached for your consideration. The ACNW's Strategic Plan is anchored to the NRC's Strategic Plan, and supports the NRC mission, vision, and select goals, strategies and substrategies relevant to NRC's responsibilities for management and oversight of commercial nuclear waste and materials. The ACNW's Strategic Plan also interfaces with the ACNW Operating Plan, which is being updated to reflect the priority issues identified herein.

One purpose of the ACNW Strategic Plan is to guide the Committee in carrying out its mission over the next year. A highlight of the plan is identification of the Committee's near-term priority issues for this year, and longer-term issues for times beyond one year. The ACNW does not plan to focus to any great extent on most of the longer-term issues this year due to resource constraints and timeliness of these issues, unless directed to do so by the Commission. In addition to priority technical issues, activities related to ACNW operational processes that we plan to initiate this year to improve our efficiency and effectiveness are identified.

We would appreciate any comments or suggestions from the Commission.

Sincerely,

B. John Garrick
Chairman

Attachment: As stated

ACNW 1998 STRATEGIC PLAN AND PRIORITY ISSUES AND ACTIVITIES

This plan provides strategic direction to the ACNW in 1998 and beyond for focusing on issues most important to the NRC in carrying out its mission of protecting public health and safety, promoting the common defense and security, and protecting the environment. It also communicates ACNW's mission, vision, goals, and priority activities and shows how these goals support the NRC's Strategic Plan.

SCOPE OF ACNW ACTIVITIES

The ACNW provides advice on issues concerning the storage and disposal of high- and low-level radioactive waste (HLW and LLW, respectively), including the interim storage of spent nuclear fuel, materials safety and decommissioning, and other issues as requested by the Commission.

ACNW MISSION

The ACNW's mission is to provide independent and timely technical advice on nuclear waste management issues to support the NRC in its conduct of an efficient regulatory program that enables the Nation to use nuclear materials in a safe manner for civilian purposes.

ACNW VISION, DESIRED OUTCOMES, AND COMMITMENTS

Vision

The ACNW strives to provide advice and recommend solutions that are forward-looking, are based upon best-available science and technology, can be implemented, and reflect the need to balance risk, benefit, and cost to society to enable the safe use of nuclear materials.

Desired Outcomes

The ACNW strives to:

1. provide technically sound and timely advice that can be incorporated into NRC technical approaches, documents, and regulations;

2. provide advice that reflects state-of-the-art science and technology that can be readily incorporated into NRC regulatory practices;

3. communicate its message clearly and concisely to its intended audience;

4. be respected by the Commission, NRC staff, EPA, DOE, and the public and be perceived as adding value;

5. be trusted by the public to provide frank, open advice, and offer a forum for public participation in the regulatory process, thereby making the regulatory decisionmaking process more transparent to the public;

6. assist in resolving conflicts between NRC and DOE, EPA, and other stakeholders by providing a forum for interaction, and by continually encouraging communication between and among these entities; and

7. operate in a spirit of openness as intended by the Federal Advisory Committee Act (FACA) and the Government in the Sunshine Act.

Commitments

The Committee makes the following commitments in pursuit of its vision:

1. be responsive to the Commission's needs;

2. remain flexible, be responsive to change, and consider various options and contingencies;

3. foster an atmosphere of mutual problem-solving with the NRC staff;

4. challenge the status quo, as appropriate, thereby becoming an "engine for change";

5. identify in advance those issues that could have an impact on NRC's ability to achieve its mission;

6. focus on risk, by asking, "what is the risk, what are the contributors to risk, and what are the uncertainties?";

7. keep abreast of international trends and developments that could influence NRC policies or approaches;

8. maintain technical excellence and independence;

9. operate in a cost-effective and efficient manner; and

10. measure the Committee's effectiveness.

GOALS AND OBJECTIVES

The ACNW has developed general goals and objectives consistent with its mission and vision. The five goals listed below serve to provide strategic direction for the ACNW this year and support select goals, strategies, and substrategies identified in NRC's Strategic Plan. For each goal, objectives that help us to focus on our priority issues are identified.

Goal 1: **Assist the NRC in positioning itself to respond to external change and uncertainty in the management of nuclear waste. This goal supports the NRC mission, vision, and select strategies or substrategies under NRC Goals 2 through 7.**

Objective 1: *Advise the Commission in a timely fashion on issues of a technical nature that may require changes in the regulations.*

Objective 2: *Inform the Commission about issues that could cause problems for the NRC or society if not given adequate attention, and recommend solutions.*

Goal 2: **Strive to ensure that NRC is employing the best science in resolving key safety issues. This goal supports the NRC mission, vision, and select strategies or substrategies under NRC Goals 2 through 7.**

Objective 1: *Keep abreast of cutting-edge methods and technologies being developed and utilized world-wide that are applicable for assessing and managing risks associated with cleanup, disposal, and storage of nuclear waste.*

Objective 2: *Advise the Commission on projected or perceived technical shortcomings in NRC staff capabilities that could adversely impact the agency's ability to address safety issues.*

Goal 3: Advice the NRC on how to increase its reliance on risk as a basis for decisionmaking, including using risk-assessment methods for waste management, that (1) implement a risk-informed approach, (2) are consistent across programs where possible, and (3) quantify and reveal uncertainties. This goal supports the NRC mission, vision, and select strategies and substrategies under NRC Goals 2 through 7.

Objective 1: Propose approaches and encourage the staff to gain a better understanding of the inherent risks of licensed activities in nuclear waste and materials, and the relationship between regulations, cost, and safety.

Objective 2: Examine risk-assessment approaches being utilized within the NRC's waste and materials programs and recommend improvements for making more transparent the underlying assumptions and associated uncertainties, incorporating greater realism where appropriate, and identifying apparent inconsistencies in approach.

Goal 4: Support the NRC in improving public involvement in its waste programs and gaining increased public confidence and respect. This goal supports the NRC mission, vision, and select strategies or substrategies under NRC Goal 6.

Objective 1: Provide opportunities through the FACA process for more public involvement in the regulatory process.

Objective 2: Recommend ways for the NRC to gain more meaningful public involvement in the regulatory process.

Objective 3: Assist the NRC in making more transparent the agency's decisionmaking process and ensuring agency documentation is thorough, clear, and readily understandable.

Goal 5: Improve the effectiveness and efficiency of ACNW operations. This goal supports the NRC mission, vision, and select strategies or substrategies under NRC Goal 7.

Objective 1: Increase the value of ACNW advice to the Commission and staff.

Objective 2: Improve and modify existing operational procedures to accomplish "more with less."

PRIORITY ISSUES AND PROCESS IMPROVEMENTS

In support of its first four goals, the ACNW has identified priority issues for this year, and longer-term issues it plans to address in the future, given sufficient resources. Also identified are the criteria the Committee uses to select its priority issues. In support of its fifth goal, the ACNW has identified priority process-related activities it plans to carry out this year to improve its effectiveness.

The priority issues identified for 1998 are considered first-tier priorities, and the longer-term issues are considered second-tier ACNW priorities. The Committee does not plan to focus to any great extent on second-tier issues this year, unless directed by the Commission, or dictated by external events, such as changes in nuclear waste legislation. Each priority issue supports one or more of ACNW's goals, as indicated.

For each first-tier priority issue, the Committee plans to prepare a task action plan that identifies the nature and scope of the issue and a strategy for addressing it, including planned product[s] and schedule, and performance measures and targets that will enable the Committee to determine if it has achieved its goals.

CRITERIA FOR SELECTING PRIORITY ISSUES

- the protection of the public health, workers, and the environment from adverse effects of the management of nuclear waste, especially in regard to disposal facilities, i.e., the risk significance of an issue;

- issues that arise from strategies and activities of licensees and applicants;

- timeliness based on when an issue is scheduled to come before the Commission, and when the advice would be of greatest benefit to influence the Commission's regulatory decisions;

- the relationship of an issue to the NRC's Strategic Plan, including trends and directions in regulatory practice, such as the adoption of a risk-informed, performance-based method of regulation and decisionmaking;

- the potential for or likelihood of an issue to pose undue risk or costs to society;

- issues that are requested for ACNW review by the Commission or Commissioners; and

- issues that arise based on the scientific and technical basis of information supporting the safety and performance assessments of nuclear waste disposal facilities, including the quality and level of expertise involved.

FIRST-TIER PRIORITY ISSUES

Viability Assessment and Site Characterization - The DOE is scheduled to complete its Viability Assessment (VA) by September 1998. The NRC staff anticipates receiving draft VA products before then, and submitting a Commission paper on its review of the VA in November 1998. In addition, the staff is developing Issue Resolution Status Reports (IRSRs) that document the status of and acceptance criteria for each Key Technical Issue (KTI) to support its review of the VA and License Application (LA), as well as a VA Review Plan. The staff's review of the VA will be a preliminary review of the eventual LA, and is expected to provide valuable insights. The ACNW plans to review DOE's conclusions and the NRC staff's review of the VA, as well as monitor the IRSRs. The ACNW also anticipates tracking the evolution of DOE's site characterization program and the DOE's waste isolation and containment strategy. **This issue supports ACNW Goals 2 and 3.**

Risk-Informed Performance-Based Regulation - The ACNW will continue to support the agency's effort to move from deterministic regulations toward risk-informed and performance-based regulation. The Committee anticipates continuing to encourage the NRC to adopt regulatory approaches that are comprehensible and enhance public understanding of the key safety issues, and continuing to encourage the NRC to use risk as a basis for setting priorities. Issues to be addressed under this topic include the following: HLW regulatory framework issues, including NRC staff's strategy to revise 10 CFR Part 60; NRC's comments on the proposed EPA HLW standard (40 CFR 197); NRC's review of DOE's proposed Siting Guidelines in 10 CFR Part 960; performance assessment, including continued monitoring of NRC's iterative performance assessments using the TPA code; problems associated with dual regulatory authority between EPA and NRC; and the evolving issues related to the use of expert judgment. **This issue supports ACNW Goals 1 through 4.**

Engineered Barrier System (EBS) - The ACNW will focus on the role of the EBS in the proposed repository, various components of the EBS and their

significance to performance, and the NRC's capability to evaluate EBS performance. A major focus will be on processes affecting waste package degradation and radionuclide release, including redox reactions, corrosion, radiolysis, microbiological effects, and reactions with introduced materials (e.g., concrete, iron). Also included will be the models and methods used to predict long-term degradation of waste packages over time, and the appropriate use of bounding models. This effort will likely include examining the use of coupled models to predict the near-field environment and its impact on containment, release, and transport of radionuclides. **This issue supports ACNW Goals 1 through 3.**

Decommissioning - The ACNW has a strong interest in waste disposal issues related to decommissioning. In the past, the ACNW has advised the Commission on streamlining the Site Decommissioning Management Program (SDMP), aspects of the Proposed and Final Rule on Radiological Criteria for License Termination, and lessons learned from decommissioning the Pathfinder site. The ACNW expects to review supporting guidance documents due in early 1998 for implementing the Final Decommissioning Rule, dose models and parameter selection criteria for decommissioning assessments, application of the LLW Performance Assessment Methodology to SDMP sites, and development of a multi-agency-sponsored decision support system to support decommissioning. Also of interest is the issue of incidental wastes at DOE facilities. Other activities may include tracking staff efforts to assess inherent risks of decommissioning and activities to simplify the decommissioning process, and assisting the Commission in contingency planning for a possible rapid increase in plant decommissioning due to deregulation. **This issue supports ACNW Goals 1 through 3.**

Research - The ACNW will examine waste-related research and technical assistance programs in the NRC. It will provide input to an ACRS report to Congress by February 1998, and a report to the Commission by June 1998. The ACNW will continue to monitor the NRC's research program to ensure that it is changing in response to the agency's shifting emphasis to risk-informed, performance-based regulation. This effort will include assuring that research is focused on helping to assess the relationship between regulations and safety, and understanding the inherent risks of licensed activities. **This issue supports ACNW Goals 1 through 4.**

As part of the priority technical issues described above, the Committee may focus on several initiatives throughout this year and beyond that would apply to some or all of these issues, such as international activities and seeking ways to improve public participation in NRC waste programs. International activities may include participating in technical exchanges with other

nations' regulatory waste programs or advisory panels. With respect to improved public participation, the Committee may explore ways to encourage the public to participate in ACNW meetings. If resources and time permit, the ACNW may also review lessons learned from other countries, other waste programs in the U.S., and directly from the public on ways to involve the public more meaningfully in NRC regulatory programs. An example may be to encourage the public to participate formally in the performance assessment process. **These issues support ACNW Goals 2 through 4.**

SECOND-TIER PRIORITIES

Repository Design/Thermal/Coupled Processes - The ACNW will continue to focus its attention on the HLW repository design, including thermal testing and results, and the significance of coupled effects on the performance of the proposed repository. The ACNW will evaluate the adequacy of models to predict repository behavior. For example, retrievability would be considered under this topic. In addition, the issue of performance confirmation, including the type and quantity of data to be collected during this phase, will be explored. **This issue supports ACNW Goals 1 through 3.**

Interim Storage Facilities for Spent Fuel - The ACNW will begin to identify issues that the NRC may need to consider and prepare for in the event that proposed legislation is enacted to create a central, interim HLW storage facility. **This issue supports ACNW Goals 1 through 3.**

DOE Oversight - The ACNW will review waste-related activities associated with NRC's possible regulation of certain DOE facilities, if NRC assumes responsibility for those activities as a result of privatization or enactment of new legislation. **This issue supports ACNW Goals 2 through 4.**

LLW and Agreement States Program - The ACNW will examine the role of the NRC in LLW disposal from the perspective that current trends in the national program may ultimately interfere with society's benefiting from the use of nuclear material. The ACNW will advise the NRC on alternatives to the current national LLW disposal program. The ACNW also may examine interactions between NRC and Agreement and non-Agreement States, and whether communications can be improved. **This issue supports ACNW Goals 1 and 4.**

Radiation Risk Levels for Low-Level Ionizing Radiation - The ACNW will continue to examine the issue of radiation risk levels for low-level ionizing radiation. The ACNW may consider the question of what research, if any, the NRC should sponsor regarding the linear no-threshold (LNT) hypothesis, and the

appropriate regulatory approach, given the uncertainty about the LNT hypothesis. **This issue supports ACNW Goals 1 through 4.**

Control and Accountability of Radioactive Devices - The ACNW will examine the NRC's role in this issue, and whether, from a risk perspective, the NRC should initiate a rulemaking or take on a more aggressive role. **This issue supports ACNW Goals 1 and 3.**

PRIORITY OPERATIONAL ACTIVITIES

Operational processes or activities that the ACNW plans to implement this year in support of ACNW Goal 5, "Enhance the effectiveness and efficiency of ACNW operations," is discussed below.

Strategic Planning - On an annual basis, the ACNW will conduct a top-down planning meeting to identify primary goals and priority issues and activities, followed by a self-assessment to measure performance against these goals. The ACNW will establish performance goals and indicators to measure effectiveness, and will use such tools as customer surveys to solicit feedback from the public on the Committee's effectiveness.

Implement Changes in Operational Procedures - To improve its efficiency and effectiveness, the ACNW will improve its current processes for the following activities: letter writing, scope and duration of meetings, interactions with Commissioners and the program offices, use of ACNW staff and consultants. Improvements may include:

- ensure letters are concise and consistent;
- allow more time for strategic planning and agenda planning during meetings;
- seek more opportunities to collaborate with ACRS to explore issues of common interest;
- spend more time meeting individually with Commissioners;
- increase the number of interactions with Program Office Directors;
- use consultants to expand expertise;
- encourage ACNW staff to initiate special projects and make presentations to the Committee;

- foster an atmosphere of mutual problem solving with the staff;
- consider options for gaining earlier access to predecisional material to assist the Committee in providing more timely advice; and
- better define and limit the number of priority topics.

UPDATING THIS PLAN

The ACNW will conduct a strategic planning meeting at least once a year, and will update this plan as needed. Revisions to the plan may be based on input from the Commission, changes made to the NRC Strategic Plan or Annual Performance Plan, results from customer surveys and self-assessments, external events and factors, and available resources.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

March 6, 1998

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

SUBJECT: ACNW'S SUPPORT FOR THE NRC STAFF'S APPROACH TO ASSESSING THE PERFORMANCE OF MULTIPLE BARRIERS

During its 98th meeting on February 24-26, 1998, the Advisory Committee on Nuclear Waste (ACNW) heard a briefing on, and discussed with the NRC staff, SECY-97-300, "Proposed Strategy for Development of Regulations Governing Disposal of High-Level Radioactive Wastes in a Proposed Repository at Yucca Mountain, Nevada." In our previous letter of October 31, 1997, "Recommendations Regarding the Implementation of the Defense-in-Depth Concept in the Revised 10 CFR Part 60," the Committee recommended, among other matters, abolishing subsystem requirements in the planned revision to 10 CFR Part 60 and instead requiring quantification of the performance of individual barriers. The purpose of this letter is to reiterate this position and to express our support for the direction the NRC staff is taking in its proposed strategy on the subject of subsystem requirements.

The basis for our recommendation was that improved information and methods of analysis, together with a determination of the risk of an appropriately defined critical group, allowed for a more direct and reliable assessment of Yucca Mountain performance than would be derived from prescribing the performance of repository subsystems. Important to our position on this approach is the requirement that, in addition to calculating the risk to the critical group, there should be the requirement that individual barriers be assessed quantitatively for their contribution. The key difference between the two approaches is quantifying subsystems to reveal their contribution to overall performance versus prescribing the performance of subsystems regardless of their contribution to overall performance. The Committee believes that the former approach provides assurance on just how effective

individual systems are in achieving an overall performance requirement while preserving the need for flexibility to achieve an optimum or a near-optimum design. Finally, the approach is believed to be an excellent example of a *risk-informed* analysis.

The staff indicated that it plans to require a system of multiple barriers without specifying quantitative requirements for individual barrier performance. Further, the staff plans to require DOE to demonstrate the contribution of individual barriers and their respective uncertainties to total systems performance by providing results of intermediate calculations within the performance assessment. The staff believes that this transparency in analyses will provide insights about the key contributors to system-level performance needed to support licensing decisions. Finally, the staff indicated that possible approaches to demonstrate individual barrier contributions and uncertainties may include the use of sensitivity analyses, scatter plots, and importance analyses.

Factors increasing confidence in a risk-informed approach to assessing subsystems, as well as total system performance measures, include: (1) over 20 years of experience in the application of probabilistic risk assessment to nuclear reactors and other systems; (2) some 15 years of experience in conducting performance assessments, especially in regard to the proposed Waste Isolation Pilot Plant and Yucca Mountain repositories; and (3) the growing amount of site-specific information obtained through the site characterization process. A key feature of the improvements in analysis is in the area of quantifying uncertainties of key parameters and models. Exposing the uncertainties associated with performance, especially the performance of subsystems, adds new meaning to the concept of multiple barriers. In one sense, knowing the uncertainties is a step toward quantifying the multiple barrier approach and providing insight on just how much safety margin actually exists.

The ACNW commends the staff for proposing to require quantification of multiple barrier performance in favor of quantitative subsystem requirements and considers the approach to exemplify a true risk-informed analysis. To implement such an approach, the ACNW articulated two primary needs in a letter dated Ocotber 31, 1997, "Application of Probabilistic Risk Assessment Methods to Performance Assessment in the NRC High-Level Waste Program." One is that performance assessments should, to the extent practicable, be developed using realistic models with uncertainties included. The Committee has also recommended that a methodology be developed, using an event tree or similar type of approach, that presents performance assessment modeling results in a way that clearly indicates the rank-ordered contributors to total system

performance (e.g., dose) and to evaluate the performance of different subsystem components. The ACNW continues to encourage the staff to explore use of a post-processing methodology that enables rank-ordering of contributors to total system performance in demonstrating individual barrier performance.

Sincerely,

B. John Garrick
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

March 6, 1998

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: NRC HIGH-LEVEL WASTE ISSUE-RESOLUTION PROCESS AND ISSUE RESOLUTION STATUS REPORTS

This letter communicates the views and comments of the Advisory Committee on Nuclear Waste (ACNW) concerning the status of the NRC staff's high-level waste (HLW) issue-resolution process and Issue Resolution Status Reports (IRSRs). During its 97th meeting, December 16-18, 1997, the ACNW heard and discussed a presentation by the NRC staff on the status of and plans for the production of IRSRs. The Committee plans to examine the reports in detail in the near future.

We understand that the aim of the issue resolution process is to resolve technical issues with the Department of Energy (DOE). In practice, the issue-resolution process is one that resolves the *method* by which the NRC expects DOE to deal with technical issues but does not always resolve the technical issues themselves. We infer that the process has two main roles. The first is to provide DOE with timely guidance from NRC on expectations for analyses and products that will be required for licensing. The second is to develop the framework for license evaluation by the NRC staff, in that the IRSRs will evolve into the Standard Review Plan. In the meantime, IRSRs will serve as guidance for the staff's review of the Viability Assessment. Several other important benefits should stem from the issue-resolution process. For example, preparation of the IRSRs necessitate technical exchanges between DOE and NRC that can lead to the definition of critical cross-linkages among key technical issues (KTIs). Also, the analyses required to produce IRSRs will naturally yield information on priorities for redirecting work, including technical assistance and research, toward important open questions.

The Committee is impressed by the way in which the issue-resolution process is being carried out and by progress in the program to date. The staff appears to be integrating and analyzing technical information into the IRSRs effectively. We are encouraged by ongoing sensitivity analyses being conducted to assess the relative significance of the KTIs and various subissues and urge the staff to use these results to reexamine, as appropriate, the KTIs and subissues. Finally, we encourage the staff to include in the issue-resolution process three-way dialogues among the NRC, the DOE, and the Environmental Protection Agency (EPA) and to establish an expanded role for the public.

Background

In Fiscal Year 1996, the NRC restructured its HLW prelicensing program to focus on only those issues believed to be critical to the performance of the proposed Yucca Mountain HLW repository. These issues are referred to as KTIs, of which there are currently ten.

NRC's refocused approach is designed to foster resolution of the ten KTIs at the staff level. Consistent with 10 CFR Part 60 requirements and a 1992 agreement with DOE, resolution at the staff level is achieved during the prelicensing period when "the NRC staff has no further questions or comments regarding how DOE is addressing the issue." Resolution of an issue at the staff level does not preclude raising and considering the issue during the licensing process. The issue-resolution process is focused on acknowledging the appropriate bounding of less significant effects and focusing interactions with DOE on real or perceived differences possessing the greatest significance to repository performance.

Comments on the Issue-Resolution Process

1. An IRSR represents the "end product" of much detailed analysis and review of DOE work accomplished and the plans for future work. IRSRs are based, in part, on results of detailed information exchanges at NRC/DOE Technical Exchange meetings and at Appendix 7 meetings.[1] The staff appears to be accomplishing the task of integrating information from such exchanges into IRSRs, including identifying critical

[1]Appendix 7 of the 1993 Revised Procedural and Project-Specific Agreements allows for interactions between the NRC onsite representative (OR) and NRC personnel assigned to the OR, and the DOE and its contractors. Although public notification is not required for these informal meetings, typically the public is invited to attend.

information that may be weak or lacking. The Committee believes that, in addition to providing detailed technical information, the IRSR activity provides a great opportunity to implement initiatives for increasing public participation in the prelicensing process. We urge the NRC staff to take advantage of the opportunity to encourage participation of stakeholders and the public in the issue-resolution process in ways that might make resolution more transparent and, perhaps, more robust to challenge.

2. One of the keys to successful issue resolution is appropriate analysis of information and models at the process level to determine how these processes translate to issues at the more abstract level of a performance assessment. In the staff presentation at our 97th meeting, we were impressed that such analyses are being performed effectively by staffs at the NRC and the Center for Nuclear Waste Regulatory Analyses. Many technical issues have been addressed in the five IRSRs issued to date. There are a number of very difficult issues on the horizon, as noted in previous letters. Examples include the potential impact of temperature and hydrology on near-field chemistry processes (Ref.1) or the need for a site-scale chemistry model to account for effects of man-made materials on the chemical environment (Ref.2). We look forward to following how issue resolution proceeds for these topics.

3. We were very encouraged to learn that the TPA-3 code is now being used to conduct sensitivity analyses within each KTI and for the total system. The ACNW has expressed in the past the need to ensure that the selection of KTIs is based on performance assessment and other information, and the need to remain flexible in the selection of KTIs based on new information. The use of the TPA-3 code in the production of IRSRs offers an excellent opportunity to examine the importance of the KTIs in the context of a PA and to reprioritize or even restructure the KTIs.

4. An issue-resolution process is a *sine qua non* for the successful solution of the problem of disposing of radioactive waste. In its report "Rethinking High-Level Radioactive Waste Disposal," the National Academy of Sciences (NAS) included in its recommendations the need for DOE and NRC to negotiate prelicensing agreements publicly in order to make progress in developing a repository for HLW. That NAS Committee also recommended involvement of the EPA because it will set the standard for Yucca Mountain. One of NRC's prelicensing objectives is to cooperate with the EPA in developing reasonable and implementable

standards[2]. Communication between the NRC and EPA is essential during this period. The ACNW believes that, as the standards and the implementation plan are developed, the NRC staff should seek to engage the DOE and the EPA in three-way exchanges in the spirit of the issue-resolution process.

5. In addition to marking progress toward the evaluation of Yucca Mountain as a repository site, the issue-resolution process is important for NRC staff in other ways. Through the work to produce IRSRs, the staff is gaining valuable experience in using and testing the tools that are needed for evaluation of a license application. That is, the activity is unique in providing direct "practice" for licensing. It also has the important benefit of keeping NRC staff involved in and aware of scientific-technical issues as they emerge, providing the stimulation and challenging environment that is essential to the retention of a high-quality technical team.

Summary

The ACNW applauds the staff for their work on developing the IRSRs that have been published to date. We encourage the staff to be aggressive in continuing and expanding their efforts. In particular, we urge the staff to make extensive use of PA in the analysis of the current KTIs and subissues of the KTIs and to explore ways to encourage participation of stakeholders and the public in the issue-resolution process.

Sincerely,

B. John Garrick
Chairman

References:

1. Report dated November 8, 1996, from Paul W. Pomeroy, Chairman, ACNW, to Shirley A. Jackson, Chairman, NRC, Subject: Comments on Coupled

[2]The staff identified in "NRC High-Level Radioactive Waste Program Annual Progress Report for Fiscal Year 1996," NUREG/CR-6513, eight revised prelicensing objectives, the first of which includes, "Cooperate with EPA to ensure development of reasonable and implementable HLW standards. Implement these standards through a simplified, risk-informed, performance-based regulation specific to Yucca Mountain."

Processes in the NRC High-Level Waste Prelicensing Program.

2. Report dated February 13, 1997, from Paul W. Pomeroy, Chairman, ACNW, to Shirley A. Jackson, Chairman, NRC, Subject: Comments on Flow and Radionuclide Transport at Yucca Mountain.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

March 26, 1998

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: RISK-INFORMED, PERFORMANCE-BASED REGULATION IN NUCLEAR WASTE MANAGEMENT

The Advisory Committee on Nuclear Waste (ACNW) welcomes the opportunity to provide input to the Commission on its draft white paper on risk-informed, performance-based regulation (RIPBR) and to clarify the issues and concepts associated with implementing a risk-informed regulatory process. The ACNW supports the development of a basic document that provides a common terminology for the RIPBR approach and that elucidates how the associated concepts can be applied to both reactor and materials regulation across the agency. Moving to an RIPBR approach will help to develop more efficient and effective regulatory measures that focus directly on public safety and will provide a basis for optimizing the regulations.

The ACNW believes that it is essential to develop a broad understanding of RIPBR throughout the agency. Because of the fundamental technical and regulatory differences among reactor systems, waste management and disposal systems, and nuclear materials management systems, it is important that the concepts articulated in the white paper be sufficiently general to encompass all of these activities and regulations. Many of the concepts in the paper are oriented toward reactor applications. The ACNW believes that the context or framework should be broadened for applying RIPBR to the management of radioactive waste and nuclear materials. The ACNW's recommendations and comments that follow are intended to help provide such a framework.

Comparisons Between Nuclear Waste Disposal and Reactor Applications

The primary differences between nuclear power plants and waste disposal facilities are the type of facilities involved and the nature and timing of the events that can lead to a threat to public safety. The events in the nuclear plant risk scenarios are related primarily to short-term equipment and human error problems, while in waste disposal facilities, they are related primarily to long-term physical processes. Waste release events generally take place over hundreds and thousands of years, while times of concern in a nuclear plant may be fractions of a second or a day. Containment in a nuclear waste facility is provided by both natural and generally passive engineered systems, while in a nuclear plant, except for basic structures and atmospheric dispersion, active systems and short-term operator response dominate the mitigation of accidents. Monitoring capability differs greatly between the two. In general,

monitors for reactor performance are on-line with short response times. For waste facilities, there are extreme limitations on monitoring reliability because of the very long times involved and the general difficulty in measuring parameters affecting an eventual threat to public safety. Differences between nuclear plants and waste disposal facilities point to the need for sufficiently fundamental concepts and definitions that embrace the full spectrum of activities regulated by the NRC.

Definitions of Terms and Concepts

Risk and Risk Assessment

The Committee believes that the definition of risk in Section 3, page 2 of the white paper is too narrow. Risk measures need to be interpreted in terms of a fundamental set of principles that serve the broad scope of activities regulated by the NRC. The ACNW recommends adoption of the *triplet definition of risk*[1] because it defines risk at a sufficiently fundamental level to apply to the wide variety of nuclear materials applications that the NRC regulates. This definition may be incorporated in a section added to the white paper before the numbered paragraphs. The triplet definition takes the view that when one asks, "What is the risk?" one is really asking three questions: "What can go wrong?" "How likely is it?" and "What are the consequences?"

The first question, "What can go wrong?" is usually answered in the form of a "scenario" (a combination of events that could occur) or a set of scenarios. Examples in the nuclear materials field include events causing early failure of the engineered barrier system in a waste repository or loss of a sealed source.

The second question, "How likely is it?" can be answered in terms of the available evidence and the processing of that evidence to quantify the uncertainties involved. In some situations, data may exist on the frequency of a particular type of occurrence or failure mode (e.g., actuarial data on losses of sealed sources or accidental overexposures). In other situations, there may be little or no data and a Bayesian approach for analyzing uncertainties will be required.

The third question, "What are the consequences?" assesses, for each scenario, the probable range of outcomes (e.g., radionuclide release rates or dose to the public) given the uncertainties. From this assessment, the important scenarios can be identified. The outcomes or consequences are the "end states" of the analyses. The choice of consequences, that is, the measures of risk, can be whatever seems appropriate for reasonable decisionmaking in a particular regulated activity. The choice could involve combinations of end states or even non-safety consequences, such as technical feasibility, cost, and schedule (i.e., programmatic risk).

Traditional and Probabilistic Approaches

The triplet definition of risk and risk assessment provides a clear framework for distinguishing between what many practitioners and regulators refer to as *deterministic* and *probabilistic*

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[1] Kaplan, S., and B. J. Garrick, "On the Quantitative Definition of Risk," *Risk Analysis*, Vol. 1, No. 1, March 1981.

analyses. The ACNW recommends that Sections 1 and 2 in the white paper be modified to incorporate the concepts discussed below. In particular, traditional deterministic safety analysis addresses only two of the three risk questions in an explicit manner (i.e., "What can go wrong?" and "What are the consequences?"). Such questions have always been the building blocks of so-called deterministic safety analysis, even in arriving at the design-basis accident. Thus, safety analysis is seen to be a subset of risk analysis. It is not a matter of deterministic analysis versus probabilistic analysis, but more a question of expanding the scope of the analyses to include consideration of likelihood in a direct manner. In simple, well-understood systems, likelihood may be easy to establish with reliability. In more complex situations, such as a waste repository analysis, the definition of likelihood becomes the central challenge.

Risk Assessment and Defense in Depth

The white paper discusses *defense in depth* (DID) in footnotes 1 and 4. The ACNW specifically endorses the Advisory Committee on Reactor Safeguards' (ACRS) recommendations[2] to modify footnote 1 and delete footnote 4. As currently drafted, footnote 4 does not recognize the difficulty in assessing the performance of multiple-barrier systems in the waste management licensing arena. The ACNW recommends that the DID concept be discussed in the main body of the paper with respect to the following issues. The white paper should make the point that a "risk-informed" approach implies quantification of all elements of defense. Although the uncertainties of some elements of defense may be substantial, the fact that they have been identified can greatly aid in deciding how much defense makes regulatory sense.

The concept of DID has always been, and should continue to be, a fundamental tenet of regulatory practice in the nuclear field. In a risk-informed era, the opportunity exists to make DID transparent. In particular, the tools of probabilistic risk assessment (PRA) and performance assessment (PA) should be challenged to expose the capability of <u>all</u> elements of defense. Good decisions on the adequacy or the necessity of elements of defense can be made only through identification of the individual performance of each defense system in relation to overall performance. A clear display of the uncertainties associated with each defense system is essential. The connection between elements of defense and overall performance measures, including their individual uncertainties, allows implementation of the DID concept.[3]

Risk Based and Risk Informed

The Committee agrees in principle with the distinction made in Sections 4 and 5 of the white paper between *risk based* and *risk informed,* whereby the former implies that decisions must be

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[2] Letter dated March 11, 1998, from R. L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: ACRS Comments on Draft Paper on Risk-Informed, Performance-Based Regulation.

[3] Letter dated October 31, 1997, from B. John Garrick, Chairman, ACNW, to Shirley Ann Jackson, Chairman, NRC, Subject: Recommendations Regarding the Implementation of the Defense-in-Depth Concept in the Revised 10 CFR Part 60.

based *exclusively* on risk assessment results, while the latter implies that decisions are based on risk in conjunction with other information. The Committee believes that a risk assessment is not a decision analysis, per se, and that risk-based approaches to decisionmaking must consider other factors, such as costs, benefits, and socio-political issues, in addition to risk.

The Committee does not agree, however, with the implication in the white paper that factors such as "the basis for current regulations, engineering analysis and judgment, and the defense-in-depth philosophy" are outside the boundaries of risk assessment. These factors affect the uncertainties of the risk measures — uncertainties that should be part of a complete risk assessment. There is nothing about the triplet definition of risk that implies that risk assessment cannot include these factors.

Performance Based

Section 6 of the white paper titled "Performance-Based" needs to be rewritten to reflect a much broader use of the term in all NRC regulations. The current waste regulations, including 10 CFR Part 60, high-level waste (HLW); 10 CFR Part 61, low-level waste; and the decommissioning rule, contain performance objectives and criteria, which are generally based on calculated dose, as key regulatory requirements. These are *performance-based* approaches. The discussion in Section 6, pages 4-6 of the white paper, does not appear to recognize that dose-based approaches are fundamentally *performance based*.

The ACNW believes that one of the major differences between materials and reactor licensees occurs in the case of performance-based regulations. For example, the first and third attributes of performance-based regulations mentioned in the white paper fail in the case of HLW regulations (10 CFR Part 60). The first attribute indicates that monitoring is essential, but the assessment of performance by monitoring of closed geological repositories is an unresolved issue. The third attribute might be taken to imply that subsystem requirements are a necessary part of the regulations. Such an interpretation runs counter to RIPBR.[4] The white paper does acknowledge these differences in footnote 4, but because possible misinterpretation of the definition of "performance-based regulations" may create an ambiguity in the HLW licensing process, the definitions should be more explicitly stated.

Regulatory Burden

The white paper, which discusses the issue of regulatory burden in Section 5 on page 4, should be augmented to address the following issue. The Committee is concerned that the spirit of the PRA Policy Statement is compromised if *risk-informed* continues to be interpreted (in the regulatory field) as *in addition to*, rather than as a *substitute for* outdated regulations. The Committee agrees that a careful transition to greater use of risk methods in regulatory decisionmaking is necessary. Although the PRA Policy Statement promises a reduced burden on licensees, the commitment by the NRC to address this issue is weak. What appears to be missing is a clear indication of how and when the regulatory relief implied in the PRA Policy

[4] See footnote 3

Statement will occur. The ACNW recognizes that the white paper is not the place to establish policy, but there is an opportunity to clarify this issue by addressing "reduction in licensee burden" explicitly in the paper.

Closing Comments

This letter has discussed RIPBR primarily in relation to geological repositories and nuclear waste isolation. Risk assessment is the essential basis upon which the overall safety of a potential repository will be judged. While very different in detail, PRA of nuclear power plants and PA of geological repositories are similar in terms of system complexity and the application of probabilistic methods to the determination of safety. The PA experience base of Yucca Mountain and the Waste Isolation Pilot Plant, together with the extensive PRA experience with nuclear power plants, provides a varied and extensive risk assessment landscape for considering the applicability of basic definitions and concepts. In simpler situations, the risk may be relatively well defined. Examining the definitions and concepts recommended in this letter against such a wide spectrum of applications gives the Committee high confidence in their applicability to all the nuclear materials regulated by the NRC. However, this conclusion presumes an extremely flexible framework for the implementation of RIPBR across the full spectrum of the materials, processes, and facilities regulated by the NRC. This is the underlying point of our recommendations. We believe such a framework is necessary and feasible. We appreciate the opportunity to offer our views on how to make the subject white paper serve this extremely important purpose.

Sincerely,

B. John Garrick
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

April 29, 1998

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: COMMENTS AND RECOMMENDATIONS ON INTERIM GUIDANCE IN SUPPORT OF THE FINAL RULE ON RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION

Dear Chairman Jackson:

During its 99th meeting on March 23-25, 1998, the ACNW heard and discussed a presentation by the Office of Nuclear Regulatory Research on NRC's final rule and regulatory guidance for demonstrating compliance with the radiological criteria for license termination.

The issue of license termination is complex because of the very broad spectrum of licensees and sites. In many cases, such as sealed-source sites, license termination is simple. In other cases, license termination can be granted only with restrictions and financial guarantees. In a few other cases, license termination may not be granted under any circumstances because of the magnitude or extent of contamination.

In the case of a simple license termination, there is no need to use dose-based models to demonstrate compliance with the final rule. For the more complex sites, it is appropriate to start the process of decommissioning using a dose-based screening model and to progress to a more detailed site-specific analysis as necessary.

In this letter, the ACNW has focused on the more complex sites requiring dose-based models. The much broader task of addressing the whole gamut of types of license terminations, especially those cases involving uranium and thorium, will be addressed in a future letter.

To gain insight on the practical application of the new approach, the Committee supports the decision to introduce the new screening tool and decision methodology and to issue the documents immediately on an interim basis for 2 years. The Committee considers the new approach using the DandD computer code to be consistent with the trend toward introduction of a risk-informed, performance-based (RIPB) philosophy in essentially all NRC licensing.

The new approach allows licensees to use a simple generic approach for low-risk sites or to use increasingly more realistic and site-specific analyses, iteratively as needed, to demonstrate compliance. The licensee can assess the relative cost and benefits of continuing with additional data collection, or remediating specific areas in order to achieve compliance.

Although the ACNW has not investigated all potential sources of conservatism in the new DandD code, we are persuaded that it is not inherently over-conservative as a screening tool. Introduction of regional parameters rather than a single set of national parameters could reduce conservatism. The 2-year trial period recommended above will allow these and similar concerns to be carefully evaluated.

There are several issues concerning the new approach in its current form that can and should be addressed. In particular:

1. The regulatory guidance documentation is formidable and likely to deter even the most motivated of licensees from using and gaining familiarity with it. The Committee urges that the staff package the guidance in a more user friendly, menu-driven electronic format that includes guidance to licensees on additional relevant NUREGs.

2. The approach outlined in the guidance for implementing the as low as reasonably achievable (ALARA) requirement may lead to unnecessary conservatism when using the DandD screening model. The Committee believes that if a licensee complies with the 25 mrem dose criterion using the screening methodology, the licensee will have met the intended ALARA requirement. (The dose calculated using site-specific analyses is expected to be lower in most cases).

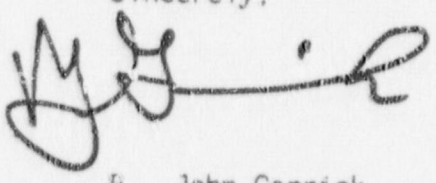
3. NRC should retain the flexibility to adjust the new DandD model if additional studies invalidate the linear no-threshold dose response hypothesis.

4. Introduction of the new decontamination and decommissioning approach will require significant resources during the 2-year trial period for field testing, training, evaluation, and guidance development. In particular, the ACNW encourages NMSS to follow-through with its plans to test the DandD code on a complex site. A strong commitment and adequate resources are needed if NRC is to move forward with RIPB regulation.

The problem of dual regulation, that is, by the Environmental Protection Agency and by NRC, was raised by representatives of the Nuclear Energy Institute during the meeting. This is a serious issue that needs to be resolved. The ACNW believes that by introducing the RIPB approach to license termination, the new methodology could assist in alleviating the conflicts associated with dual regulations as it should lead to more defensible and consistent regulatory decisions.

The ACNW plans to become more familiar with the DandD code and the license termination process during the next 2 years of testing and will keep the Commission informed of any significant developments.

Sincerely,



B. John Garrick
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555-0001

June 19, 1998

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

SUBJECT: ACNW COMMENTS ON NRC'S REVIEW OF THE DOE VIABILITY ASSESSMENT

The purpose of this letter is to provide ACNW comments on the potential role of the NRC staff in evaluating DOE's Viability Assessment (VA), which the DOE plans to submit to Congress in September 1998. During its 98th meeting, February 24-26, 1998, the ACNW heard presentations by the DOE staff on the status of and plans for completion of the VA. During its 100th meeting, April 21-23, 1998, the ACNW heard presentations by the NRC staff on its plan for reviewing the VA. Additional insights were gained during a two-day Working Group meeting on the near-field environment and the performance of engineered barriers held during the 101st ACNW meeting, June 10-12, 1998.

The VA will consist of four parts: (1) the preliminary design concept; (2) the total system performance assessment (TSPA-VA); (3) the license application (LA) and cost estimate; (4) the costs of construction and operation. The staff's review of elements (1), (3), and (4) will be limited. Specifically, for element (1), the staff will review the technical feasibility of the reference design as it relates to post-closure performance of the proposed repository. For element (3), the staff will review the adequacy of the test plans and schedules, and for element (4) it will review the performance confirmation plans and schedules. There are no plans to include pre-closure issues in the review, except as they may affect post-closure performance, nor are there plans to consider options not part of the reference design.

The staff's principal effort will be the review of element (2), TSPA-VA. The staff's TPA-3 code will allow it to conduct this review in the appropriately independent manner and also will allow it to be rigorous in expressing difficulties it may discern in DOE's analyses.

The ACNW concludes that the plans of the NRC staff to focus the review on post-closure analyses in the VA are appropriate, given the limited time and personnel available for the task. The post-closure aspects of the analyses to be presented in the VA are the aspects that are most likely to determine whether the Yucca Mountain site will continue to be technically viable. We also agree that the NRC staff should devote the greatest portion of its review to the reference repository design, as opposed to alternatives.

Although the ACNW agrees that post-closure analyses should be a primary focus of the review, we think that the NRC staff should use this opportunity to position itself for the more comprehensive reviews that will be required in an LA. We recognize that the staff has allocated only two months for its "formal" review of the VA. Nevertheless, we believe that NRC staff should continue its effort to evaluate the VA in more detail for issues that may be important for licensing beyond the two-month period.

We present below several specific observations and recommendations.

OBSERVATION 1: The review of the VA provides an opportunity for DOE and NRC to learn to focus on issues important to licensing an HLW repository. The staff plans to use the Issue Resolution Status Reports and the acceptance criteria included therein to guide the review of the VA.[1]

RECOMMENDATION 1: We urge the staff to undertake the review of the VA with the recognition that it provides an opportunity for exploring the development of a Standard Review Plan for reviewing the HLW LA. In particular, we recommend that staff evaluate the adequacy of the acceptance criteria in the IRSRs for use in review of the LA.

OBSERVATION 2: At its 98th meeting, the ACNW asked representatives of DOE whether Volume I of the VA would provide a systems engineering overview of the entire VA. The ACNW believed that DOE's answer was ambiguous. In the absence of a systems approach to the VA, there is a danger that NRC's review could become bogged down in detail and miss critical linkages between components of the total repository system.

RECOMMENDATION 2: NRC should ensure it takes a systems approach in its review of the VA, by emphasizing the relationships between component performance and total system performance. Such an approach, which focuses on the contribution of individual components, is consistent with the evaluation of multiple barriers within a defense-in-depth and a risk-informed philosophy.

OBSERVATION 3: The pre-closure aspects of the proposed repository have received relatively little attention to date. The pre-closure period for an HLW repository will exceed the operating period for many other facilities licensed by the NRC. Furthermore, DOE has recently speculated that the operating phase of the planned repository may be extended to 100 years or longer.

RECOMMENDATION 3: The NRC staff should give some attention to pre-closure issues in its review of the VA. The ACNW believes that pre-closure issues (e.g., transportation of waste, waste acceptance for emplacement, licensing of operators, etc.) will be very important to the

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[1]"Overview of NRC's Issue Resolution Process, Accomplishments, and Plans for Review of DOE's Viability Assessment," M. Federline and others, Proceedings of the Eighth International Conference on High-Level Radioactive Waste Management, American Nuclear Society, May 11-14, 1998.

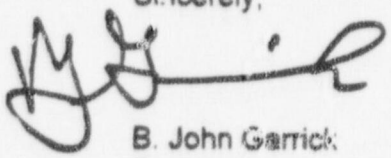
successful disposal of waste. Some attention to review of pre-closure aspects of the VA will be valuable to the NRC staff in preparation for work on the LA and would provide important feedback to DOE that should allow the licensing process to proceed smoothly. We believe that pre-closure issues must be considered more prominently than in the past to ensure the overall success of the project. Given that the Division of Waste Management may be occupied by post-closure aspects of the review, it may be helpful to use expertise elsewhere in the agency to consider pre-closure issues. For example, many of the issues relevant to the handling of spent fuel should be applicable to the proposed surface facilities at Yucca Mountain.

OBSERVATION 4. Major changes are taking place in the area of the engineered barrier system (EBS). The NRC staff has strongly focused its efforts in the past decade on the long-term far-field natural geological system. It is critical that the NRC staff adapt to changes in the importance being placed on the EBS.

RECOMMENDATION 4. The NRC staff should understand the strengths, deficiencies, and tradeoffs in the details of the EBS design, design options, and fabrication considerations that will be presented in the VA. The ACNW believes that the details of the design will assume critical importance beyond the VA if DOE proceeds with an license application. The NRC staff should use the review of the VA as an opportunity to begin a critical evaluation of the EBS design details.

We trust that our comments on the review of the viability assessment will be useful.

Sincerely,



B. John Garrick
Chairman

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